
High-redshift AGN science
with Constellation-X
Contributions from
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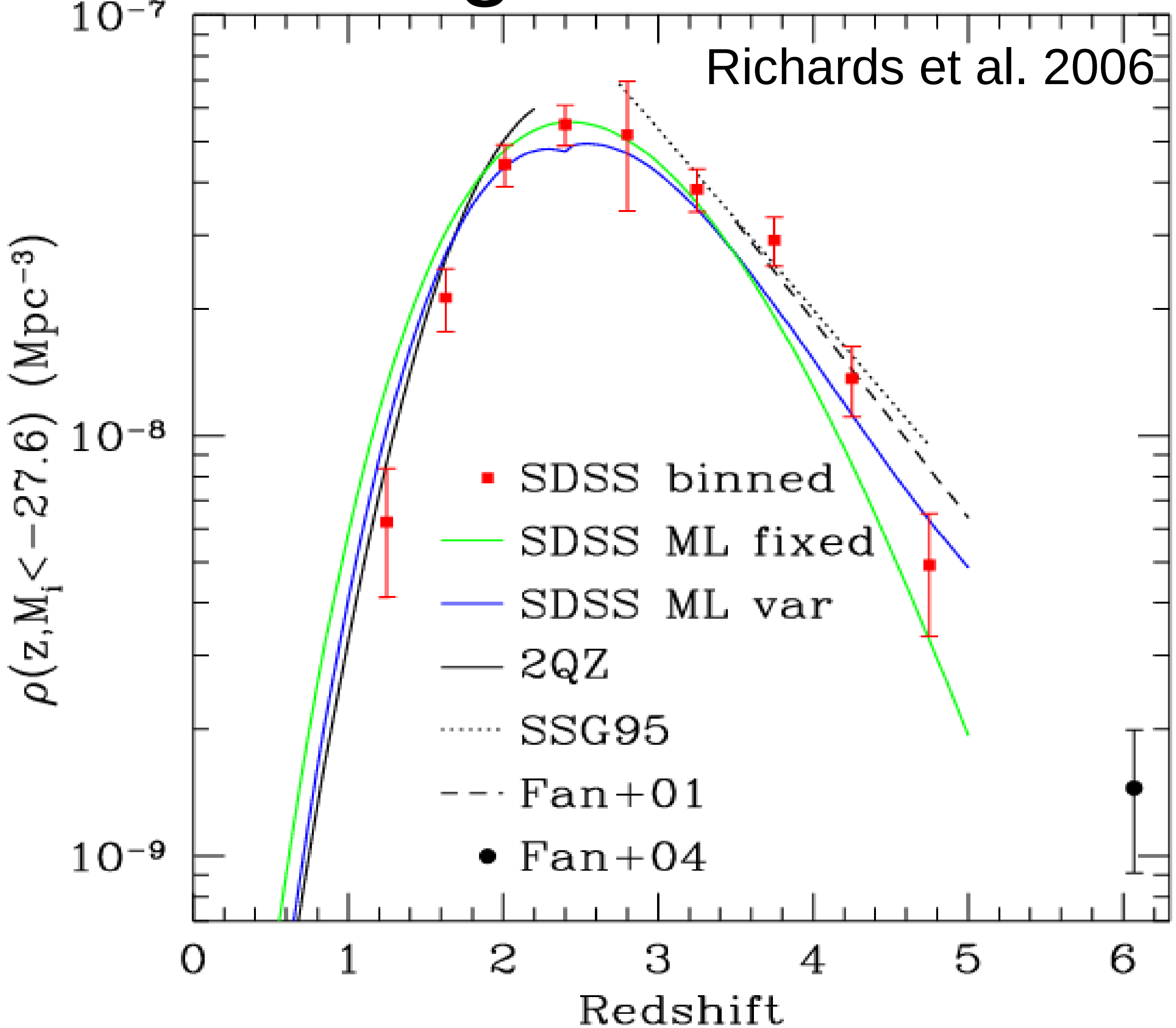
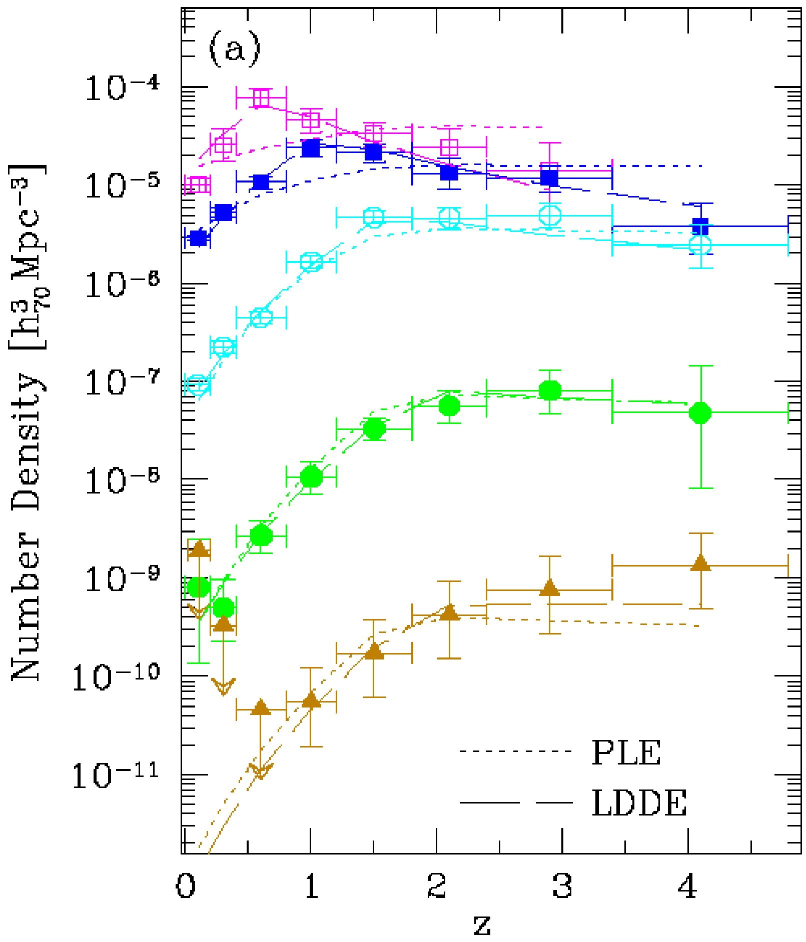
The story of the accretion history of the Universe begins at z>2



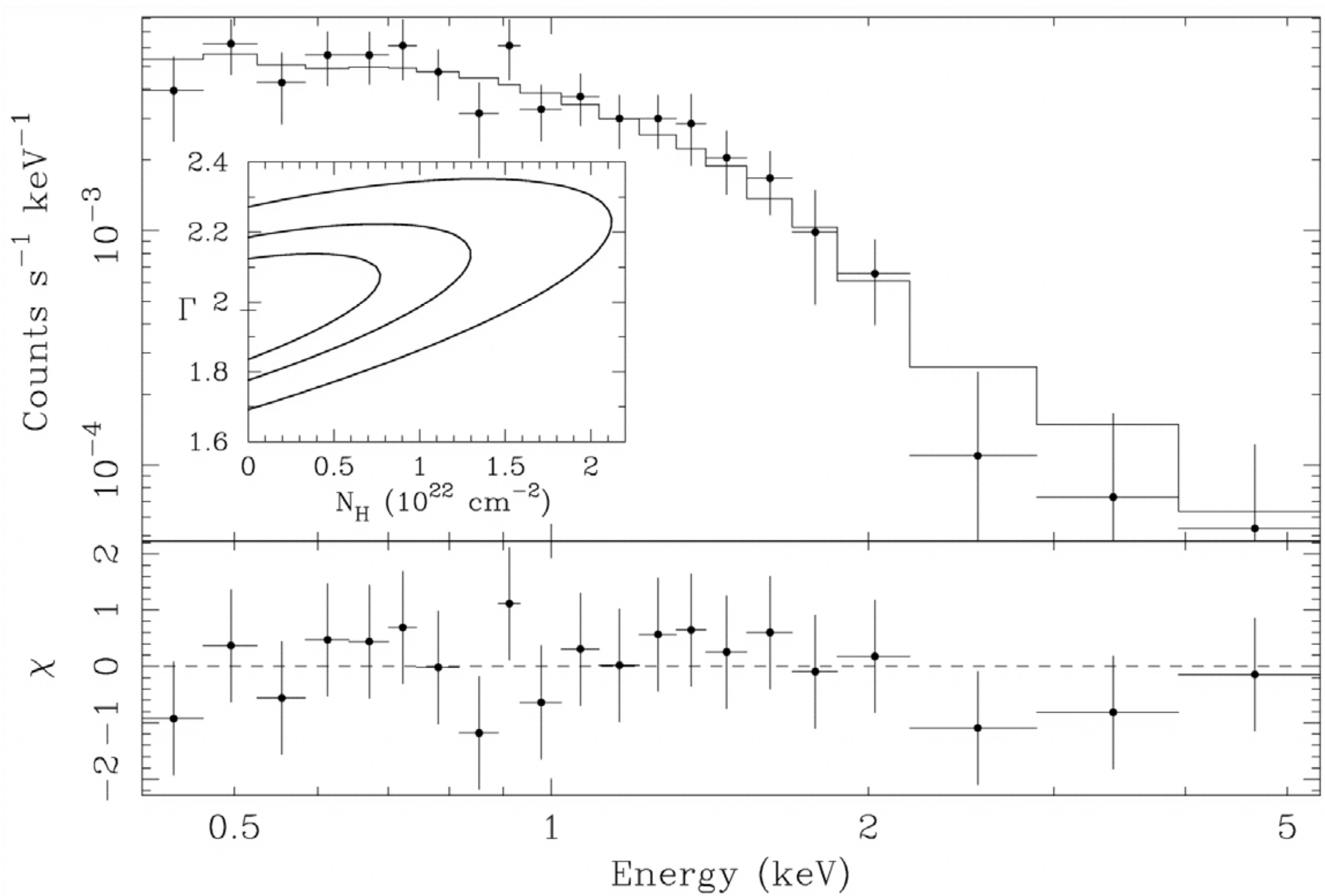
Anti-hierarchical growth of black holes



The most luminous AGN peaked at higher redshifts than moderately luminous AGN: most massive black holes grew first

X-rays provide most direct probe of regions around the black hole and hence the possibility to explore this growth (e.g., accretion-disk environment, outflows, and obscuration)

Current z~4 QSO X-ray spectra



Average spectrum is characterized only by Γ and N_H.

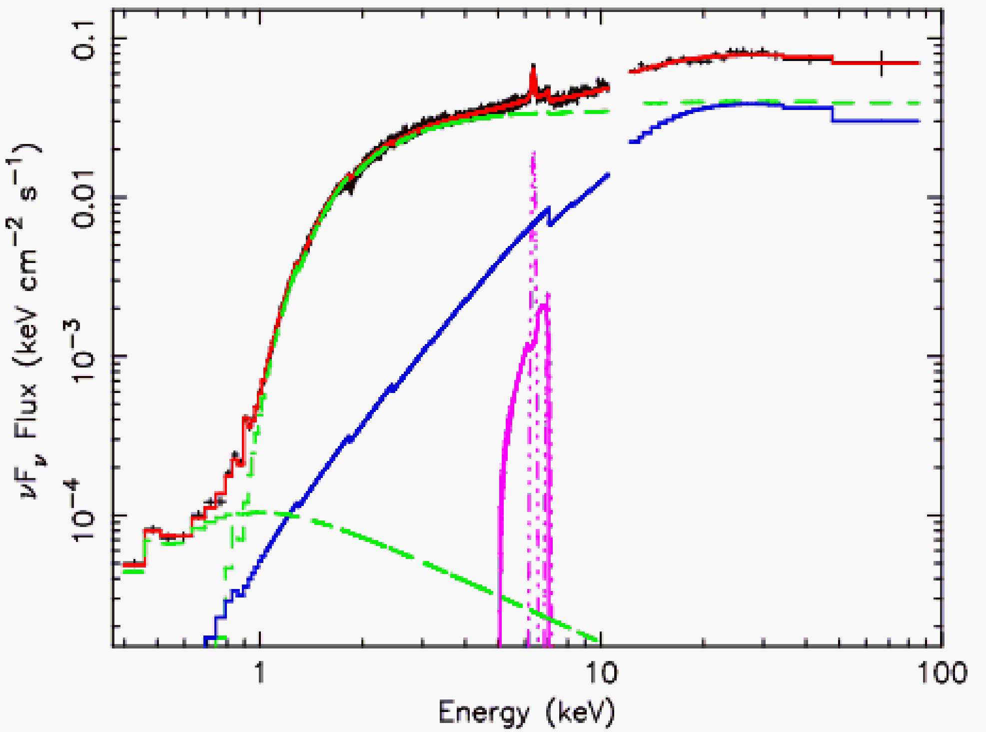
(Vignali et al. 2003)

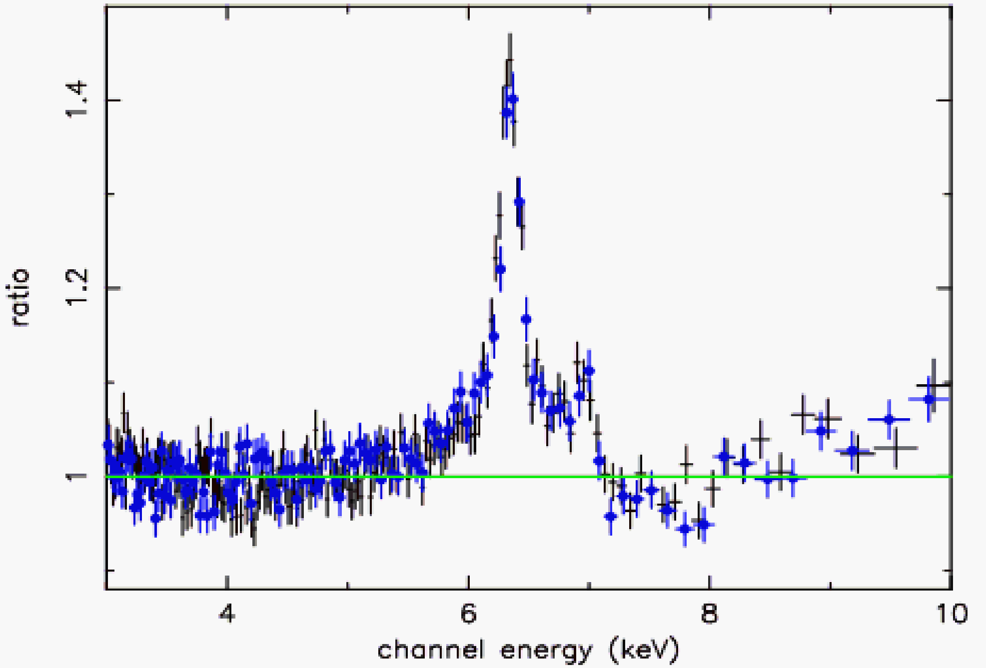
But AGN are more complex

Seyfert 1.9 MCG 5-23-16 with *Suzaku*

Complex continua: unabsorbed scattered component, absorbed direct component**, complex Fe emission, Compton hump.**

(Reeves et al. astro-ph/0610436)

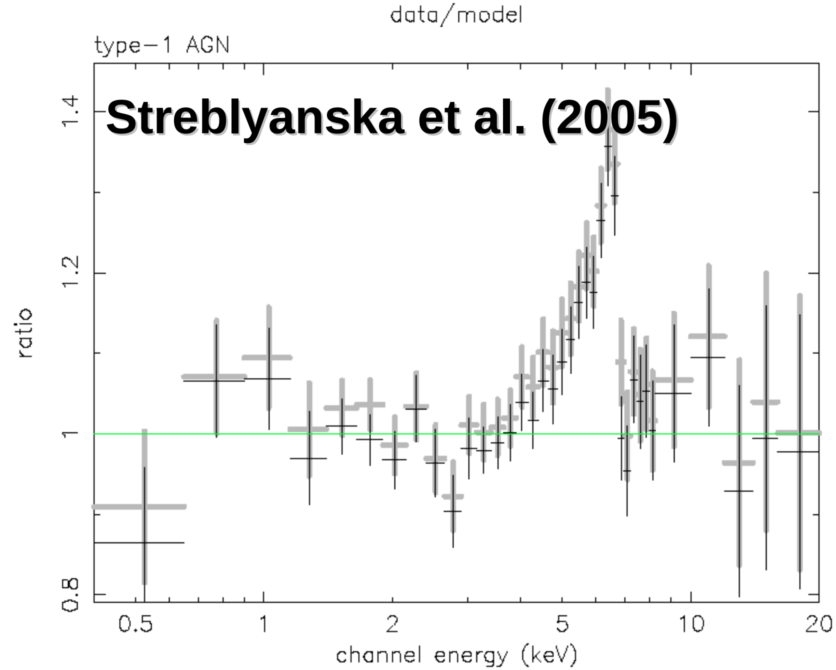




Relativistic Fe K and black-hole spin

Are high-redshift black holes rapidly spinning and hence produce broadened relativistic Fe K emission?

Theory predicts no evolution in black-hole spin out to z=5 (Volonteri et al. 2005) but the identification of possible broadened Fe K in stacked Type 1 AGN provides evidence that broad lines could be prevalent in high-redshift AGN



Stacked XMM spectrum of Type 1 AGN in Lockman Hole

To study Fe K lines, require >10,000 counts (e.g., Guinazzi et al. 2006). To probe moderate-luminosity Seyferts (L_X>5x10^{43} erg/s) exposures at z~0.5 will require 100 ks, z>1 sources will require ~1 Ms exposures

- **Largest field of view will provide best "value for money" for ultra-deep exposures**

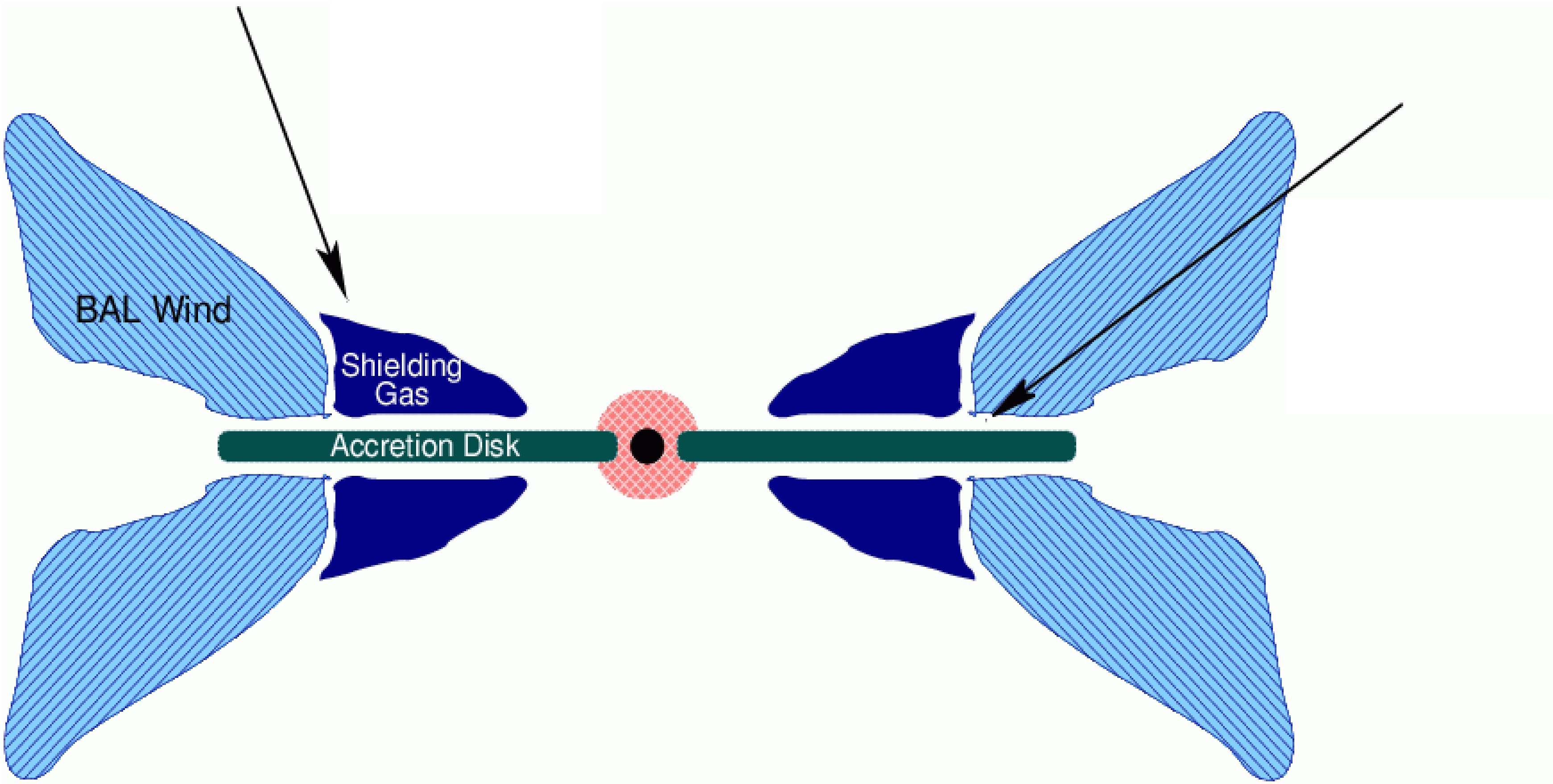
AGN feedback at high redshift

If feedback truly plays a key role in the evolution of galaxies, we must explore it at the redshifts where it is dominant.

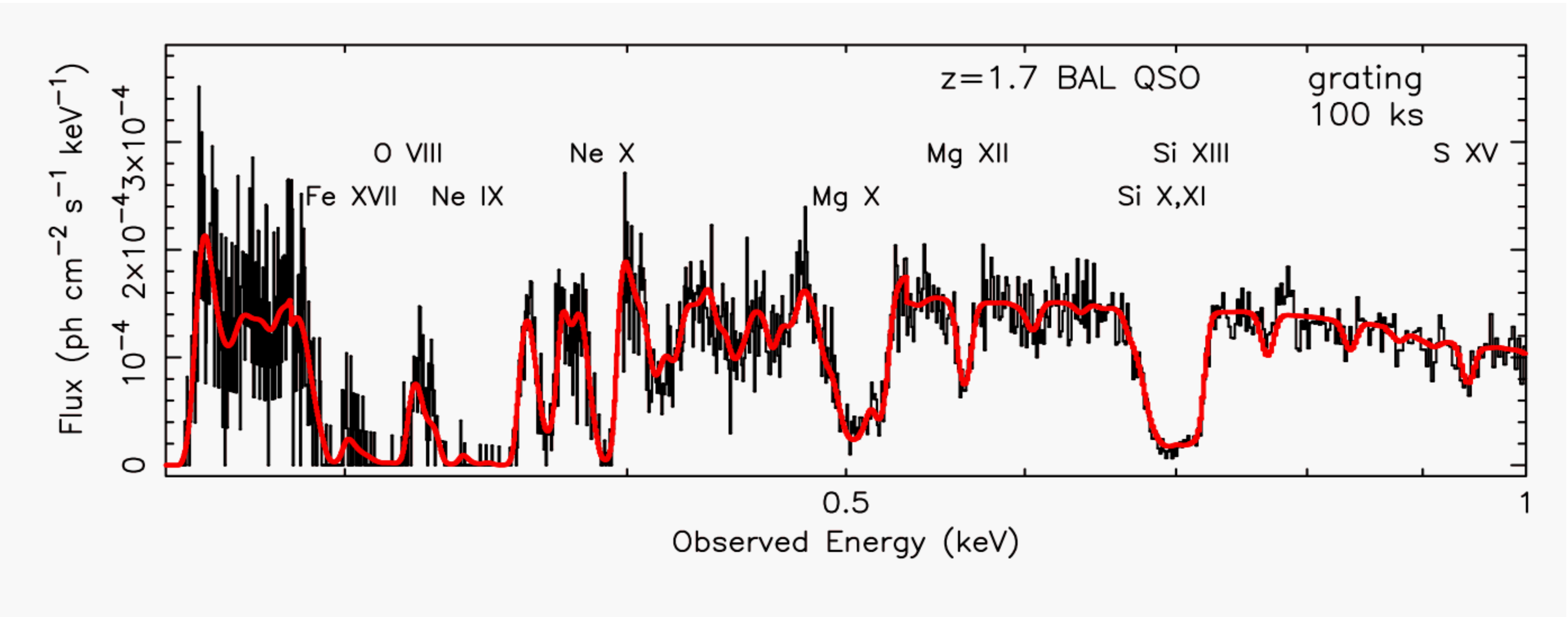
Furthermore, while jets may be important in clusters, they cannot be important in the evolution of individual galaxies if all massive galaxies go through an active phase -- only 8-40% of AGNs are radio-loud.

We must look to accretion disk winds as the most viable solution to the feedback problem.Con-X can study such winds both in emission and absorption.

Wind Model



Outflows in Absorption: Grating

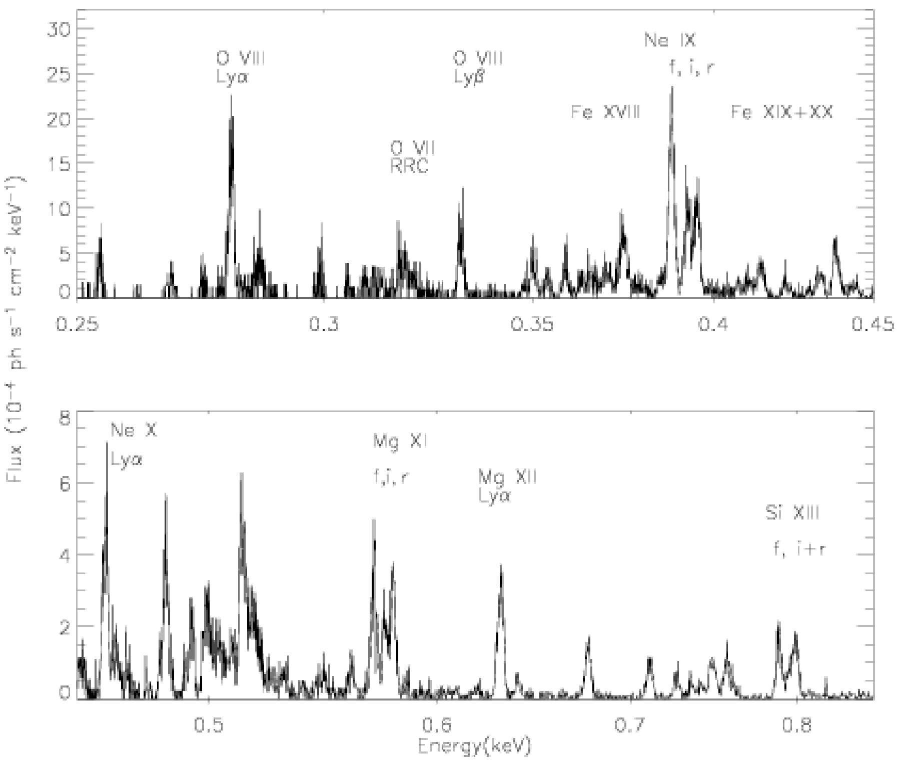


Model: 2 component outflow with different ionization states, velocities, and velocity dispersions. <u>Resolved</u> with <u>gratings</u>.

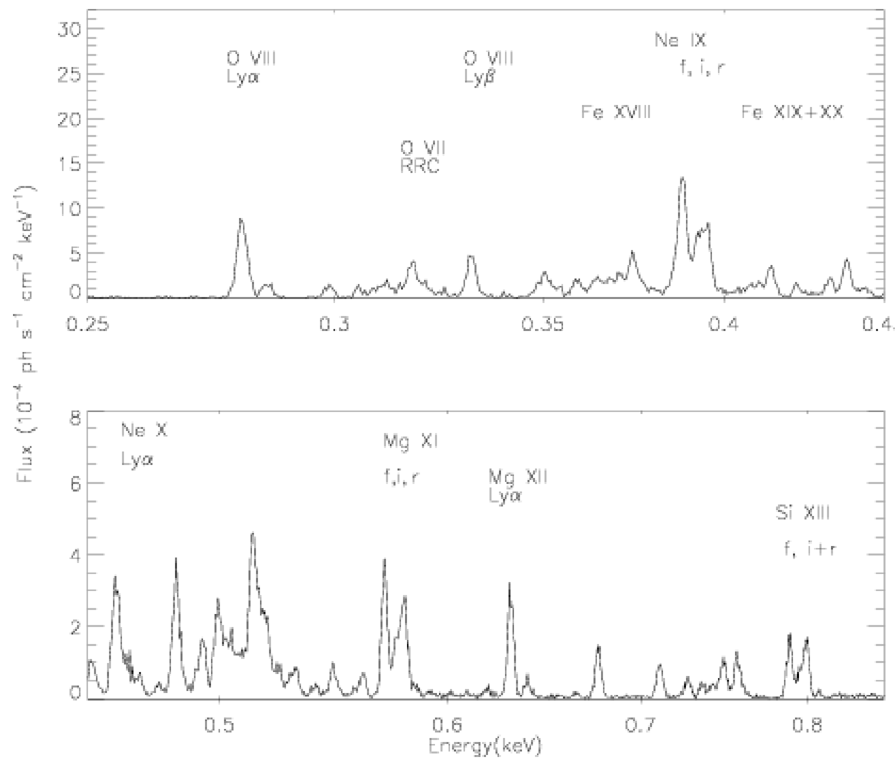
(Flux matches PG1115+080 with z=1.7.)

Accretion Disk Winds need high resolution at low energies

Con-X RGS
(Delta IVH version)



Con-X XMS

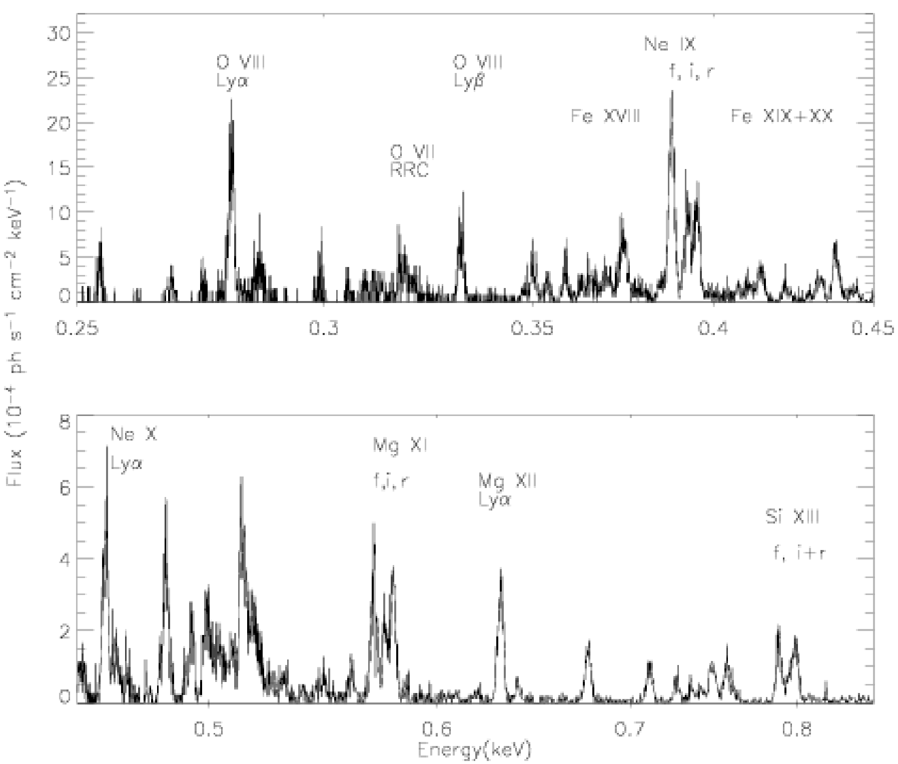


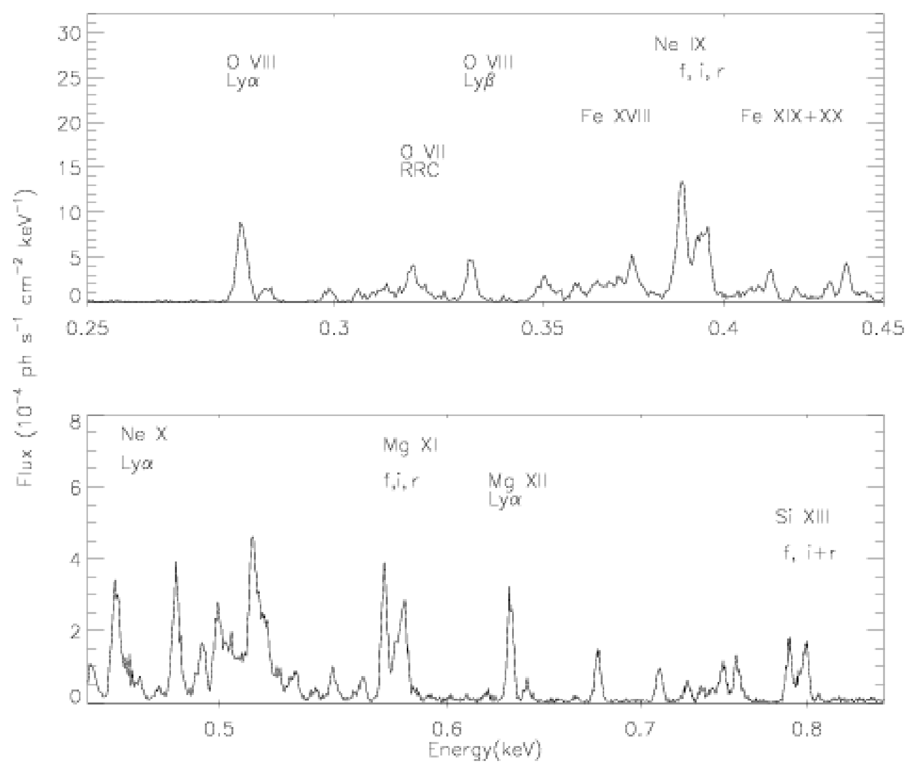
Can marginally separate the r, i+f triplet lines, which are density/column density diagnositics.

But our ability to determine **mass outflow rates** will be severely limited (because we need to measure the **velocity** of the gas and Con-X Lite will not have the resolution at <1keV) and this is what is most crucial to AGN feedback studies.

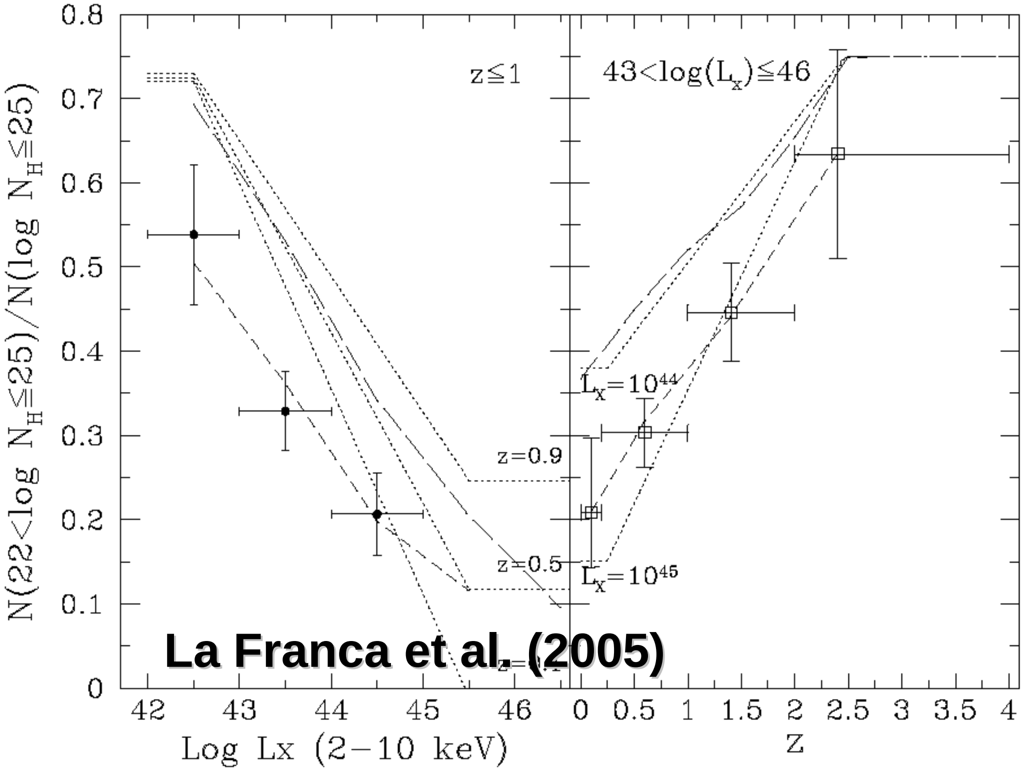
Con-X RGS
(Delta IVH version)

Con-X XMS





Obscured Growth of Black Holes



La Franca et al. (2005)

The majority of BH growth occurs in an obscured phase: is the obscuration both

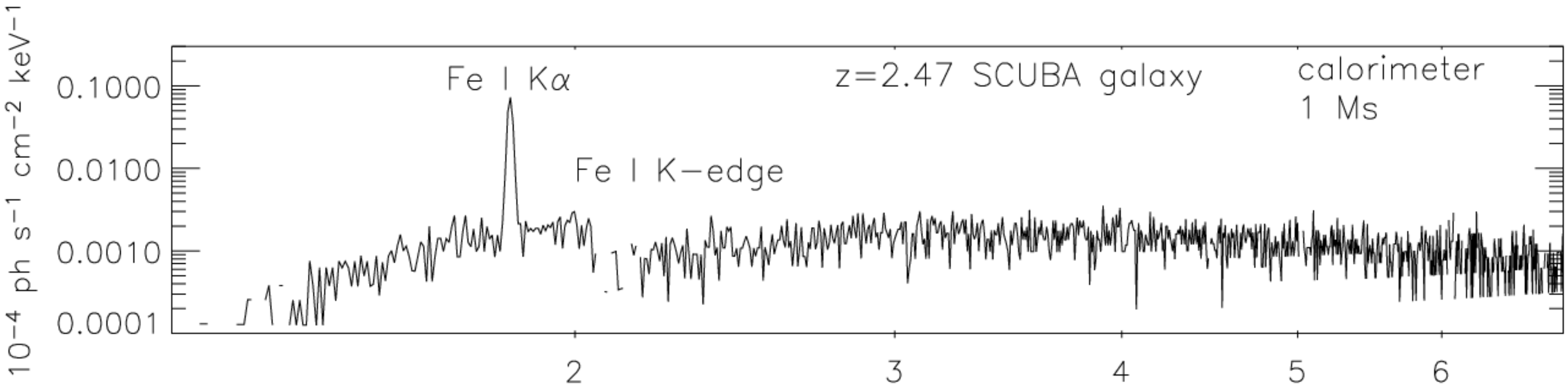
(a) luminosity dependent (receding torus) and

(b) redshift dependent (gas rich, rapidly growing BHs at high-z)?

Need >10 keV sensitivity to effectively measure of intrinsic luminosity of the most obscured AGN (sources that dominate the Cosmic X-ray Background)

Need "complete" census of both obscured and unobscured AGN population to constrain efficiency of BH growth (mass-to-light ratio) and hence relate integrated mass accretion to the local BH mass density

Need for Con-X spectroscopy



At high redshift we are still relying on crude X-ray spectra… Con-X can provide good-quality spectra even for X-ray faint Compton-thick AGN

Summary

Calorimeter excellent for tracing changes in accretion properties in AGN (relativistic Fe K out to z~0.5-1) and in characterizing obscured AGN:

1. Gratings will provide measurement of mass-outflow rates (potentially key science over the next decade)

2. E >10 keV sensitivity will enable measurements of intrinsic luminosity of the most obscured AGN

- **BONUS: QSOs provide unique opportunity to probe e.g., Compton hump at higher redshift (bandpass up to 40 keV translates to 200 keV at z>4)**

3. Largest field of view will provide best "value for money" for ultra-deep exposures which will be required to do e.g., broad Fe K science at *z*>0.5